

# ***PTC HMI***

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# ***PTC HMI***

## **Topics**

- **HMI Design Guidelines**
- **HMI Studies**
- **HMI Features**
- **Loco Display Simulation**
- **PTC Railway Worker HMI**

# ***PTC HMI***

## **HMI Design Guidelines**

- **Used CONOP example as baseline**
- **Applied lessons learned from NAJPTC Workshops and past LM HMI development**
- **Adhered to PTC Standards and interoperability Objectives**
  - **ATCS 320, LSI M591, NPRM Appendix E to subpart H**
- **Initiated rapid prototyping during requirements development phase**
- **Employing Graphical User Interface (GUI) Tools with Automated Code Generation**

# ***PTC HMI***

## **PTC HMI Studies**

- **Multiple Meetings held with Project Office, SE, FRA, Amtrak, UP, BLE and other NAJPTC experts in attendance**
  - November 2000 through May 2001
  - Demonstrated HMI Prototype simulation
  - Adjudicated HMI Comments
- **HMI Study results presented at PTC PDR (July 2001)**

## **Backup Studies**

- **Display Symbols; Graphics Vs Text**
  - Graphics are superior when multiple symbols need to be discerned <sup>1</sup> (e.g. Speed, Authorities, restrictions, control points, sensors etc...)
  - Text is superior when operator needs to focus on singular symbol <sup>1</sup> (e.g. Critical Alerts)
- **Comparison Vs Description**
  - Quantitative Reasoning should rely on comparison to minimize reliance on operators memory to analyze data

<sup>1</sup> NASA Report Jan 01 1987 “ A study of information transfer performance of pictorials vs text”  
<http://techreports.larc.nasa.gov/ntrs>

<sup>2</sup> NASA Report 28 November 1994 “Principles of Information Display for Visualization Practitioners”  
<http://www.nas.nasa.gov/Research/Reports...hreports/1994/html/NAS-94-002.html>

# ***HMI PTC***

## **Key Features**

- **Graphics based Primary Data display**
  - Graphical cues, hints and differentiation mitigate display area constraints
- **Windows based secondary data controls and dialogs**
  - Push up menus and Pop Up dialog boxes
- **Text data reinforces graphics**
  - Provides diverse backup data source
  - Promotes critical data awareness

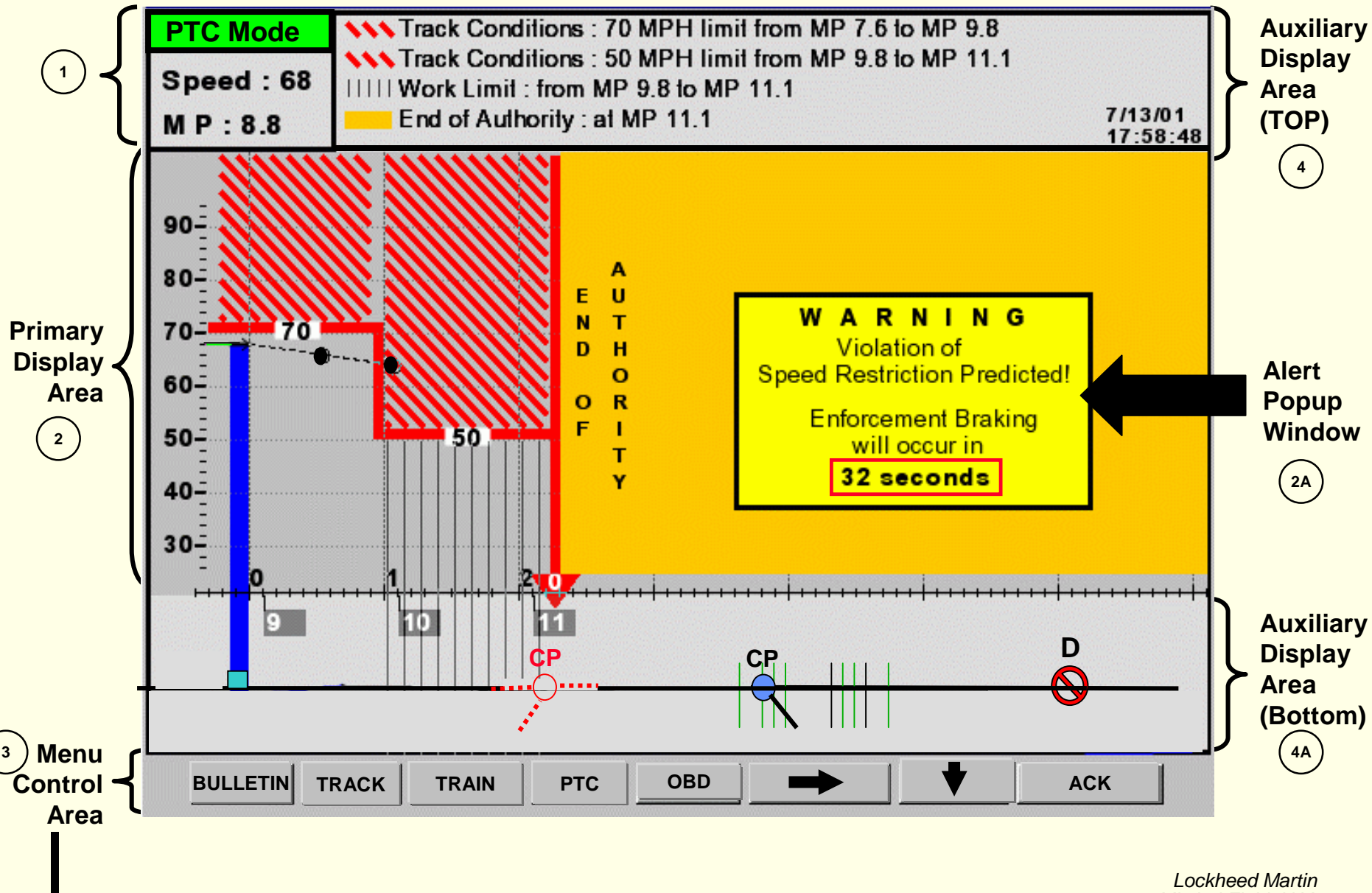
# ***P42 Cab Layout (Amtrak 75)***

## **Engineer Console Eye Level**



# PTC HMI Display Areas

(refer to notes page for description)

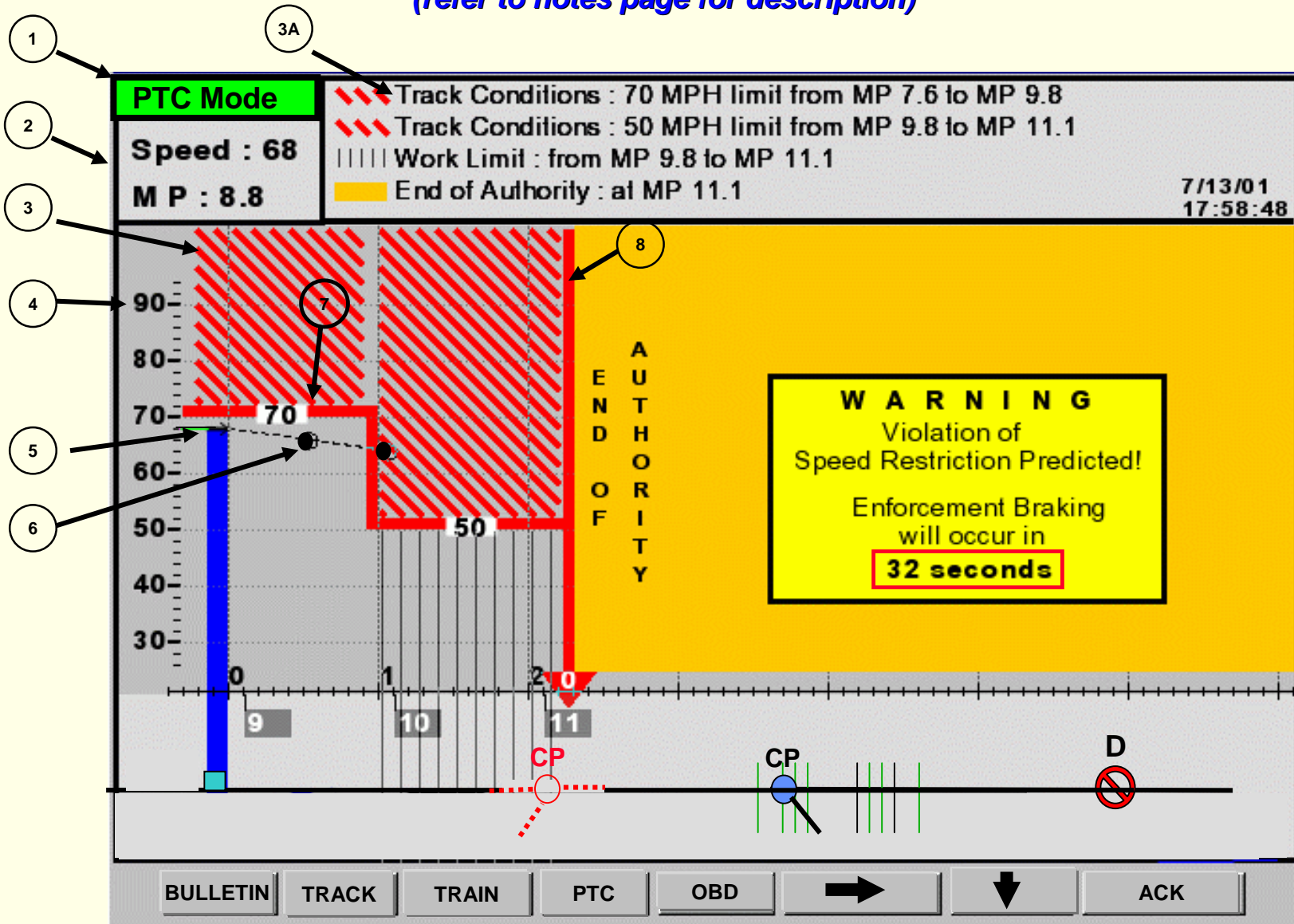


# ***PTC HMI Display Area Notes***

- 1. Critical Data Area - **Continuously available area containing speed, location and mode data**
- 2. Primary Area - **The Main display area showing train speed dynamics and train location relative to speed, authority and work limit targets within a six mile display horizon.**
- 2.A. Pop-Up display area - **The pop - up widow will activate to the left-most side of the Primary area taking up no more than than half the distance of the train's display horizon**
- 3. Menu Control Area - **Continuously displayed/available area containing eight HMI Software Function keys that are aligned with eight hardware buttons located just below the HMI flat panel display.**
- 4. Auxiliary Area Top - **This area is reserved for the summary of Bulletin data (Form A, B, C) data. The data is displayed upon operator demand and may be blanked to reduce display clutter. Text data that supports the primary display graphics will become active in synch with the activation of its graphical counterpart when the display area is active. This area may also be used to display track grade data on operator demand.**
- 4A. Auxiliary Area Bottom - **Reserved primarily for track profile data such as control point status and configuration (CP), Crossings |, and Defect detectors (D). This area is used to depict the train length and its relative location on the track. Work limit area graphics extend to this area to emphasize that men are physically on or near the track.**

# Primary Display Components

(refer to notes page for description)

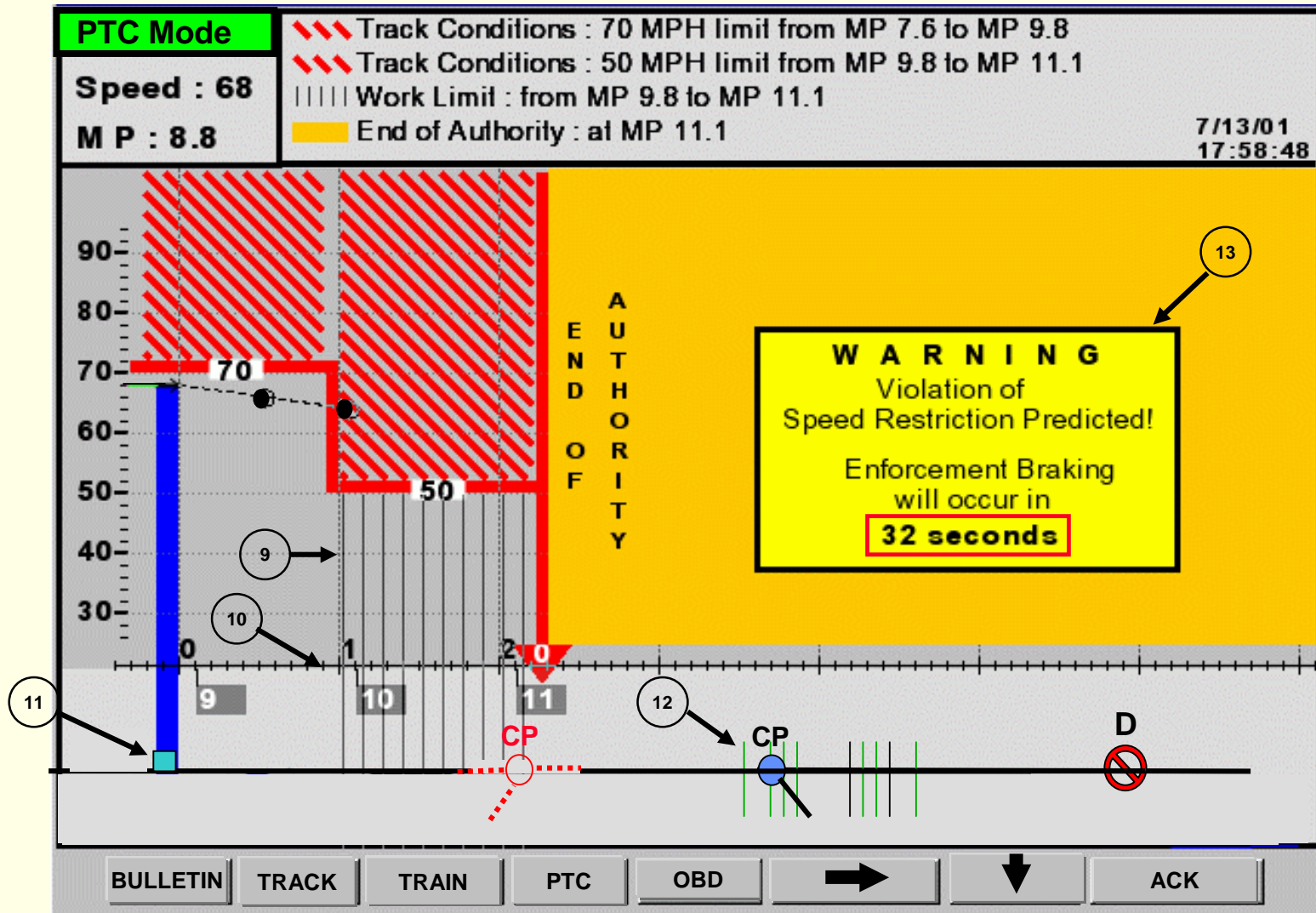


# ***PTC HMI Display Component Notes***

- 1. Mode indicator - **Continuously visible indicator providing Maintenance and Operational mode indication (e.g., Power Up, Initializing PTC, Active PTC)**
- 2. Speed and Location - **Continuously visible indicator providing Textual Speed and Mile Post location data.**
- 3. Speed Restriction (Limit) Graphical Hint - **Graphical cue to indicate type of speed restriction. May also be used to indicate restrictive speed zones.**
- 3a. - Text Reinforcement - **Text reinforces graphical cues on Main Dynamic display and provides degree of diversity. Text located in Auxiliary window which can be raised and lowered on operator demand.**
- 4. Vertical Speed Scale - **The speed scale is a linear scale that provides a constant speed value scale which will adjust in the vertical in conjunction with the train speed pointer to encompass the full range of possible train speed within a limited vertical window area. The speed scale also provides a reference for speed limit restrictions in the display horizon.**
- 5. Train Speed Pointer - **The train speed pointer provides a graphical representation of the speed using the speed scale as well as a change in vertical height as the train accelerates and decelerates. The vertical distance between the speed pointer and on coming speed limit graphics provides a comparative relationship between the train's speed and the oncoming speed limits. The train pointer remains stationary in the horizontal and extends down into the bottom auxiliary area and into the train position and length indication.**
- 6. Speed Prediction Indicator - **A graphical vector with two filled in circles representing the train's predicted speed and location in 30 seconds and 60 seconds respectively. The upward and downward direction of the vector represents whether the train is predicted to be accelerating and decelerating respectively.**
- 7. Speed Limit Graphic - **Represents the most restrictive speed limit for a prescribed area in the display horizon. A text box reinforces the speed limit and is located within the graphic. The text box will also be used to indicate whether the area is a restrictive speed restriction and will contain the text "Restrictive" as required.**
- 8. Speed Change or Authority Limit Bar - **This vertical bar represents a change in speed or end of a train's authority to move (speed=0). The bottom of this bar contains a graphical hint of the lower speed limit if it is currently off the scale with respect to the train's current speed.**

# Primary Display Components

(refer to notes page for description)



# ***PTC HMI Display Component Notes***

## ***(Cont.)***

- **9. Work Limit Graphic - Work limit start at the associated speed limit for the area and extends to the track graphic in the bottom auxiliary area. The graphical representation shall reflect acknowledged, un-acknowledged, and “expired but not cancelled” work limit orders.**
- **10. Train location Scale - The train location scale is a linear scale that provides an absolute reference of the location of graphical entities (track profile data, speed limit boundaries, speed prediction indication, work limit) with respect to the front (point movement) of the train. The scale is fixed and has major scale marks in miles and minor scale marks of 2/10ths of a mile. The scale extends at least six miles in the front of forward motion of the train and at least 1/4 mile from the rear of forward motion of the train.**
- **11. Train Position and Length Indicator - This indicator is connected to the train speed pointer and varies in horizontal length which represents the length of the train. The length measurement is relative to the train location scale. The position of the the train with respect to track profile icons can be determined from the train location scale.**
- **12. Track Profile Indicators - track profile indicators consist of mileposts, crossings, control points, hot box and defect detectors. Track profile indicators move along the horizontal and relative to the speed of the train.**
- **13. Alert /Data entry and status window - The Alert window is activated by the PTC system in the Pop-Up window area in response to the PTC system requiring the operator to interface with train controls (e.g., reduce throttle, apply brakes), acknowledge a critical message (i.e., work limit acknowledgement) or alerting the crew to enforced braking in process. The activation of an alert window is accompanied by a distinctive audible alert associated with the type of alert. Critical warning messages will be distinct using flashing, bolding or color change. Data entry and status windows also pop up in this area in response to operator interaction with the Menu controls.**

PTC Mode

Speed : 63

Miles : 0.7

Press < Bulletins > button to display active bulletins

4/26/01  
09:47:47

120

CAUTION

Reversing!

9  
8  
7  
6  
5  
4  
3

0

1

2

3

4

5

6

7

121

122

123

124

125

126

Grade  
0.5%

Bulletins

Track

Train

PTC

OBD



ACK

PTC Mode

Speed : 63

Miles : 0.7

Press < Bulletins > button to display active bulletins

4/26/01  
09:47:47

120



Neutral



0

1

2

3

4

5

6

7

121

122

123

124

125

126

Grade  
0.5%

Bulletins

Track

Train

PTC

OBD



ACK

PTC Mode

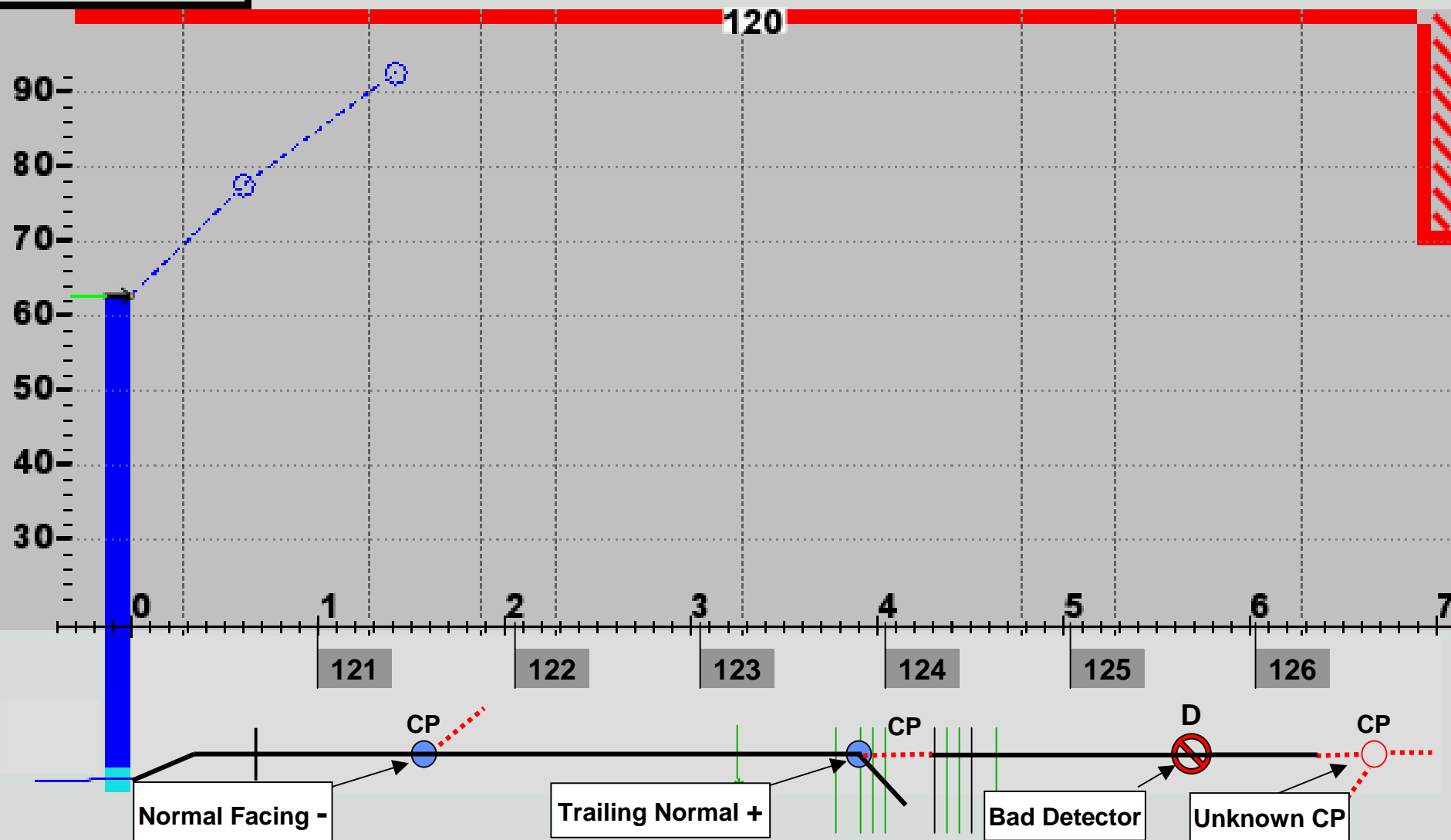
Speed : 63

Miles : 0.7

Press < Bulletins > button to display active bulletins

4/26/01

09:47:47



Bulletins

Track

Train

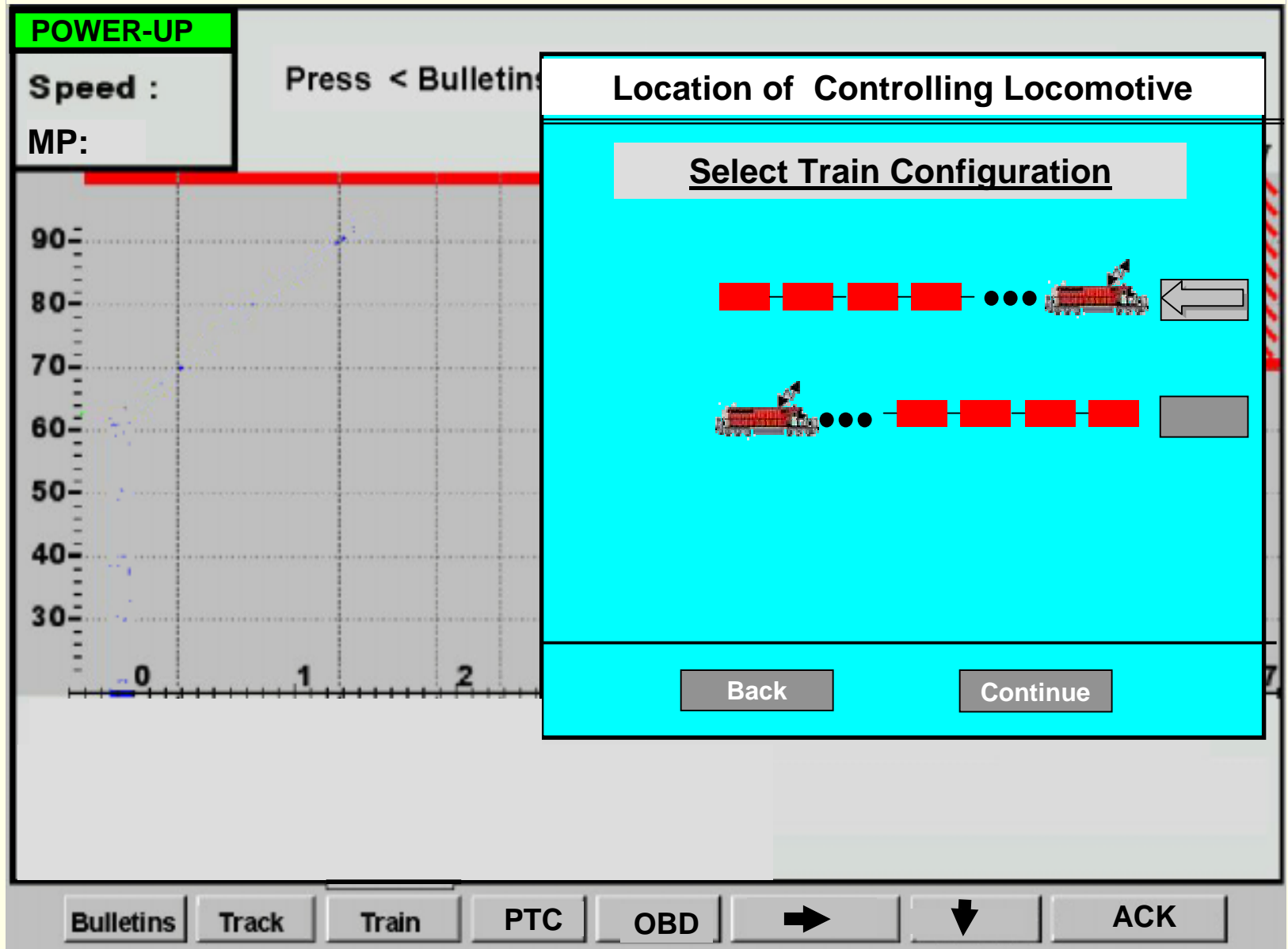
PTC

OBD



ACK

# PTC HMI Secondary Display

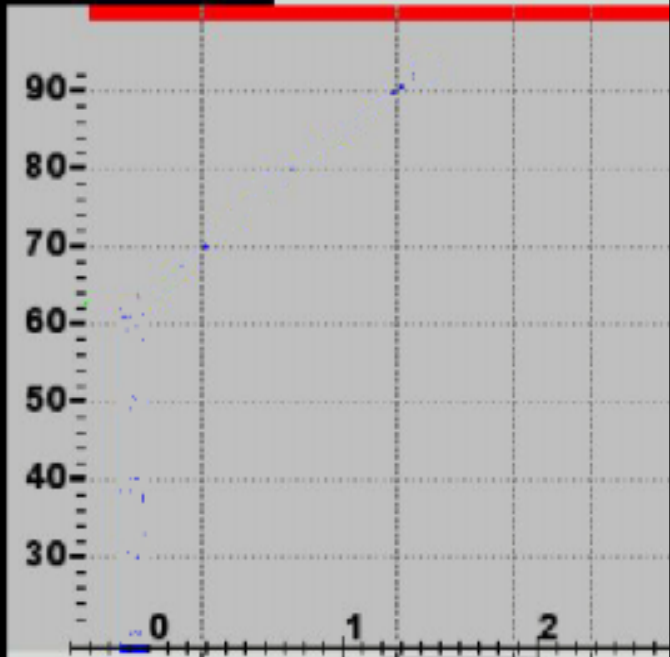


# PTC HMI Secondary Display


POWER-UP

Speed :  
MP :

Press < Bulletins

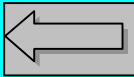


You have selected the following  
Locomotive Location:




Continue Selection

Short hood  
forward



Long hood  
forward



Number of locomotives  
between Controlling Loco  
and the front of the train

Number of cars  
between Controlling Loco  
and the front of the train

Back

Confirm


Bulletins


Track

Train

PTC

OBD





ACK

**Speed :**  
**Mile Post :**

Press < Bulletins / Summary > to display Bulletins

**Bulletin**

Form A  
Form B  
Form C  
Summary

**Bulletin**

**Track**

**Train**

**PTC**

**OBD**



**ACK**

Speed :  
Mile Post :

Press < Bulletins / Summary > to display Bulletins

Form A

NO. 91577 ON FT WORTH (537) 10/06/2000  
TO CNW 8722 SOUTH AT FORT WORTH

BETWEEN POINTS SHOWN IN LINES BELOW DO NOT EXCEED  
SPEED GIVEN: (UNDER COLUMN HEADED "FLAGS" ENTER "NOT"  
IF FLAGS ARE NOT DISPLAYED. USE COLUMNS HEADED "AT MP"  
AND 'FOR DIR' WHEN FLAGS ARE DISPLAYED LESS THAN  
DISTANCE DESCRIBED BY RULE 5.4.2 TO INDICATE LOCATION  
AND DIRECTION.)

-----

LINE NO. 1. LIMITS FROM MP 215.50 TO MP 216.00 MPH 40  
TRACK AFFECTED MAIN FLAGS AT MP FOR DIR  
FROM 09/21 1800 TO /

-----

LINE NO. 2. OK 10/06/00 1245 DISPATCHER: FRH

-----

Exit

Bulletin

Track

Train

PTC

OBD



ACK

Speed :  
Mile Post :

Press < Bulletins / Summary > to display Bulletins

### Train

Consist ➤  
Wheel Diameter ➤  
Test ➤  
Status

Review  
Update

Bulletin

Track

Train

PTC

OBD



ACK

Speed :  
Mile Post :

Press < Bulletins / Summary > to display Bulletins

Clear

Erase

1

2

3

4

5

6

7

8

9

0

Accept

Press ACK to Enter

Wheel Diameter Update

Current Wheel Diameter Measurement

Entered on: 11/21/2001 0800

Diameter (cm): 75.25

Exit

Bulletin

Track

Train

PTC

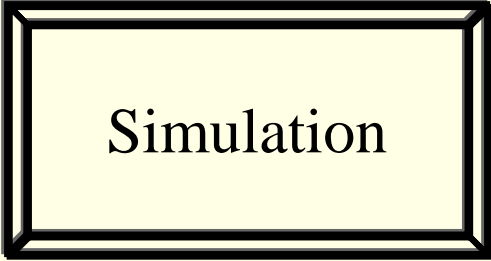
OBD

→

↓

ACK

# ***PTC HMI Demo***



Simulation

# ***Roadway Worker Terminal Human Machine Interface (HMI)***

- **Display Warnings**
- **Display Authorities**
- **EIC Functions:**
  - User Login
  - Request Temporary Speed Restriction
  - Release Temporary Speed Restriction
  - Request Work Zone
  - Release Track and Time
  - User Logout

# Main Screen

## {Warnings}

### Main Menu

1. Request Temporary Speed Restriction
2. Release Temporary Speed Restriction
3. Request Work Zone
4. Release Track and Time
5. Logout

Please Enter Selection: \_

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		

## {Authorities}

# ***RWT Warnings Displayed on Main Screen***

Predicted violation of authority limit by locomotive UP 1234.

Emergency brake application by locomotive UP 1234.  
Press function key F3 to acknowledge.

## Main Menu

1. Request Temporary Speed Restriction
2. Release Temporary Speed Restriction
3. Request Work Zone
4. Release Track and Time
5. Logout

Please Enter Selection: \_

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		

# RWT Authorities Displayed on Main Screen

## Main Menu

1. Request Temporary Speed Restriction
2. Release Temporary Speed Restriction
3. Request Work Zone
4. Release Track and Time
5. Logout

Please Enter Selection: \_

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		
Joliet	12	----	----	----	----	----	Y	----	----	Y	----	----
Joliet	13	----	----	UP1234	----	----	Y	----	----	Y	----	----

<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Road: _____</p> <p>Subdivision: _____</p> <p>Description: _____</p>   <p>Speed Restriction: _____</p> <p>Direction: _____</p> <p>Restriction Type: _____</p> <p>Train Type: _____</p>   <p>From MP: _____</p> <p>To MP: _____</p>   <p>Free Text: _____</p> </div> <div style="width: 50%; text-align: center;"> <h3 style="margin: 0;">Request Temporary Speed Restriction</h3>   <p>Start Date: _____</p> <p>Start Time: _____</p> <p>End Date: _____</p> <p>End Time: _____</p> <p>Daily/Continuous: ____</p> <p>Flag Entries: _____</p> <p style="margin-left: 40px;">(rule exceptions) _____</p> </div> </div>												
<b>F1: Submit Request</b>						<b>F12: Cancel Request</b>						
Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		

# Request Temporary Speed Restriction Data Entry

Road: UP  
 Subdivision: Springfield  
 Description: Main

Request Temporary Speed Restriction

Speed Restriction: 15  
 Direction: South  
 Restriction Type: Head End Only  
 Train Type: All

Start Date: 1/1/01  
 Start Time: 00:01  
 End Date: \_\_\_\_\_  
 End Time: \_\_\_\_\_  
 Daily/Continuous: C  
 Flag Entries: 269.5 \_\_\_\_\_  
 (rule exceptions) \_\_\_\_\_

From MP: 270.3  
 To MP: 271.8

Free Text: \_\_\_\_\_

F1: Submit Request

F12: Cancel Request

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		

# ***Request Temporary Speed Restriction Data Submitted***

Road: UP  
Subdivision: Springfield  
Description: Main

Speed Restriction: 15  
Direction: South  
Restriction Type: Head End Only  
Train Type: All

From MP: 270.3  
To MP: 271.8

Free Text: \_\_\_\_\_

## **Request Temporary Speed Restriction**

Your Request Has Been Sent  
Please Wait...

Start Date: 1/1/01  
Start Time: 00:01  
End Date: \_\_\_\_\_  
End Time: \_\_\_\_\_  
Daily/Continuous: C  
Flag Entries: 269.5 \_\_\_\_\_  
(rule exceptions) \_\_\_\_\_

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		

# ***Request Temporary Speed Restriction Data Accepted***

Road: UP  
Subdivision: Springfield  
Description: Main

Speed Restriction: 15  
Direction: South  
Restriction Type: Head End Only  
Train Type: All

From MP: 270.3  
To MP: 271.8

Free Text: \_\_\_\_\_

## **Request Temporary Speed Restriction**

**Your Request Has Been Accepted**

Start Date: 1/1/01  
Start Time: 00:01  
End Date: \_\_\_\_\_  
End Time: \_\_\_\_\_  
Daily/Continuous: C  
Flag Entries: 269.5 \_\_\_\_\_  
(rule exceptions) \_\_\_\_\_

**F12: Return to Main Menu**

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		

# ***Release Temporary Speed Restriction Data Entry***

Road: UP  
Subdivision: Springfield

Release Temporary Speed Restriction

Dispatch #: 5  
Line # (0-all): 0

From MP: 270.3  
To MP: 271.8

F1: Submit Request

F12: Cancel Request

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		

# Request Work Zone Data Entry

Road: UP  
 Subdivision: Springfield  
 Description: Main

Request Work Zone

From MP: 270.3  
 To MP: 271.8  
 Stop Required (Y/N): Y

Start Date: 1/1/01  
 Start Time: 00:01  
 End Date: 1/6/01  
 End Time: 06:00  
 Daily/Continuous: D  
 Flag Entries: 269.5  
 (rule exceptions) \_\_\_\_\_

Special Instructions: Contact EIC John Smith for permission to enter limits

F1: Submit Request

F12: Cancel Request

Road/Subdivision	Auth #	Limits Granted			From			To			Clear Track By	Extended Time Until
		Type Code	Behind Eng # Dir	Joint With	Track	CP or Loc	Sw Y/N	Track	CP or Loc	Sw Y/N		